Breakthrough solutions for HAMR nanoantenna for next-generation ultra-high density magnetic storage

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Researchers at Nano-Meta Technologies Inc. (NMTI) in the Purdue Research Park have shown how to overcome key limitations of a material that could enable the magnetic storage industry to achieve data-recording densities far beyond today's computers.

The new technology could make it possible to record data on an unprecedented small scale using tiny "nanoantennas" and to increase the amount of data that can be stored on a standard magnetic disk by 10 to 100 times.

The storage industry's technology strategy, called heat-assisted magnetic recording (HAMR), hinges on the design of the nanoantenna, or near-field transducer (NFT), said Urcan Guler, chief scientist at Nano-Meta Technologies.

HAMR harnesses "plasmonics," a technology that uses clouds of electrons called surface plasmons to manipulate and control light. However, some of the plasmonic NFTs under development rely on the use of metals such as gold and silver, which are not mechanically robust and present a challenge in fabrication and long-term reliability of the HAMR recording head.

Researchers from Nano-Meta Technologies and Purdue University are working to replace gold with titanium nitride. The material offers high strength and durability at high temperatures, and its use as a nanoantenna paves the way for next-generation recording systems, said Vladimir M. Shalaev, scientific director of nanophotonics at Purdue's Birck Nanotechnology Center and a distinguished professor of electrical and computer engineering.

The researchers have modified the physical properties of titanium nitride, tailoring it for HAMR.

A team from Nano-Meta Technologies and Purdue has authored an article on the need to develop new materials as alternatives to gold and silver for various plasmonic applications, using HAMR as an example. The article was published online this month in the journal Faraday Discussions.

The technology could make it possible to circumvent the disk-storage-capacity limits imposed by conventional magnetic recording materials. Normally, lenses cannot focus light smaller than the wavelength of the light itself, which is hundreds of nanometers across. However, nanoantennas allow light to be focused into spots far smaller than the wavelength of light, making it possible to increase the storage capacity of the medium.

Industry has been reluctant to adopt titanium nitride for potential new plasmonic applications because making nanoantennas out of conventional titanium nitride leads to excessive "self-heating" through absorption of the input laser light, hindering performance. Common titanium nitride also undergoes oxidation reactions at high temperatures that degrade its optical properties, said Ernesto Marinero, a professor in Purdue's School of Materials Engineering who is an expert in magnetic recording and joined the university after a long career in the storage industry.

To address both problems, the researchers have modified titanium nitride to significantly reduce its intrinsic light absorption, thereby paving the pathway to overcome the self-heating roadblock. Furthermore, the researchers also have solved the oxidation problem by protecting the material with an ultrathin coating that prevents oxidation without affecting the material's optical properties.

The Faraday Discussions article was authored by Guler; Alexander Kildishev, an associate research professor of electrical and computer engineering; Alexandra Boltasseva, an associate professor of electrical and computer engineering; and Shalaev.

HAMR uses a laser to illuminate a nanoantenna, a tiny structure with the ideal shape and size for "optimum light coupling" to produce the required spot size onto the recording medium. The antenna couples electromagnetic energy into a small spot, creating heat that allows a magnetic head to write the ones and zeroes required for data storage onto a spinning disk. HAMR allows the use of recording materials with superior magnetic properties to guarantee the stability of the nanoscale ones and zeroes of future computer drives.

Shalaev and Boltasseva formed Nano-Meta Technologies Inc. The company is focusing initially on three applications: HAMR; solar thermophotovoltaics, in which an ultrathin layer of plasmonic metamaterials could dramatically improve solar cell efficiency; and a new clinical therapeutic approach using nanoparticles for cancer treatment.

The research has been supported by the National Science Foundation through a Small Business Innovation Research award granted to NMTI for the development of a durable HAMR NFT.

"Phase one, which is a feasibility project, is yielding promising results and NMTI is seeking industrial partners for product development," Guler said.

More information: "Plasmonics on the slope of enlightenment: the role of transition metal nitrides." DOI: 10.1039/b000000x

Provided by Purdue University

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